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PLANTS AS INTELLECTUAL PROPERTY: AMERICAN PRACTICE, LAW, AND POLICY IN WORLD CONTEXT

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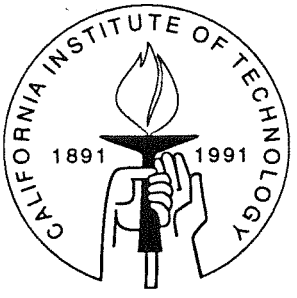

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PLANTS AS INTELLECTUAL PROPERTY*

Since the late nineteenth century, private plant breeders in the United States, like those elsewhere, have long been concerned with what they term "breeder's rights" or what lawyers call the protection of intellectual property. Such property arises, in general, from the investment of time, money, and ingenuity that produces a new type of plant variety or -- a much disputed category -- exploits the finding of one. (A plant variety generally means an assemblage of cultivated individuals that is distinguished from its counterparts in some set of characters -- physical, morphological, or otherwise -- and that retains its distinguishing features when reproduced.) Having created such property, private breeders have held that they have a right in it. They have also sought to obtain protection of their property right in various ways, including private arrangements and, with increasing vigor, public policy and law, especially in the patent system. Horticulturalists first attempted to obtain patent protection for their products in 1906. They did not succeed until the passage of the Plant Patent Act in 1930, which was a limited victory for plant breeders, since it applied only to horticultural products.[1] The 1935 Bankhead-Jones Act, which included major provisions for agricultural research, and the 1952 revision of U.S. patent law, a sweeping overhaul, were both silent on issues of intellectual property protection for plants in general.

However, in 1970 Congress provided protection for a broad range of plants by enacting the Plant Variety Protection Act (PVPA).[2] Since then, the range and type of intellectual property protection for living organisms has been enlarged in a whirlwind rush -- with a 1980 act to extend the coverage of the PVPA; the 1980 Supreme Court decision of *Diamond v. Chakrabarty*, which gave patent protection to living microrganisms; and the extensions of that decision by the United States Patent and Trademark Office in 1985 and 1987, through, respectively, *Ex parte Hibberd*, which ruled that any type of plant could in principle be patented, and *Ex parte Allen*, which held that so could living animals.[3]

The tale raises important historiographic questions: Why was the victory of the Plant Patent Act not enlarged until 1970? Why was it broadened then? And why has it been so much expanded since then? An exploration of these questions reveals a good deal about the historical interplay among breeding science, economic interests and circumstances, private arrangements, and public

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law that has shaped intellectual property protection in plants. We here examine that interplay -- first, as background to the shift in 1970; second, to account for the shift; and third, to suggest reasons for the speedy extension of intellectual property protection to living organisms in general during the last quarter of a century.

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Through much of the nineteenth century, plant innovation in the United States depended heavily upon plant importation. In 1839, the U.S. Patent Office began importing plant varieties from around the globe, a practice formalized, in 1862, in the act that established the Department of Agriculture (USDA), which, among other things, enjoined the agency "to procure, propagate, and distribute among the people new and valuable seeds and plants." The Department accomplished the distribution by sending out packets of seeds -- in 1897, a record-high of more than twenty-two million of them -- free to American farmers. However, in the late nineteenth century, partly in response to the glut in the world wheat markets, the Department of Agriculture began to develop a commitment to the innovation of new grains of high quality that might find strong export market demand.[4] By the early twentieth century the Hatch Act of 1887, which established federal support for agricultural experiment stations, and the Adams Act of 1906, which provided federal grants for agricultural research, were providing increasingly handsome federal subsidies for research in plants. These measures reflected Congressional acceptance of the idea that American agriculture was shifting from an extensive growth pattern arising from the addition of land, water and labor to an intensive growth pattern, the result of more scientific application of those resources.

Since the biological needs of its crops determined how each farm arrayed its resources, public agricultural stations soon began systematic breeding to improve the seeds that initiated the process. The large majority of plant development occurred in the greenhouses and test plots of the USDA and of the many agricultural experiment stations attached to state colleges and universities. In a recent study, Jack R. Kloppenburg, Jr., concluded that through the first third of the twentieth century, the history of plant improvement "is essentially that of the continuous growth and elaboration of publicly performed research and development in a virtual vacuum of private investment." In 1934, one hundred twenty-eight principal varieties of wheat were grown in the United States; seventy-eight per cent were of public origin.[5]

However, the free availability of publicly developed plants and seeds helped to foster the development of private plant breeding activities. Land-grant universities provided scientifically trained breeders and progressive farmers receptive to well-bred seed. The USDA also promulgated standards of practice and definition in seed testing that rationalized assessments of

seed quality. Most important, the new varieties provided by public stations were appropriated by private breeders, who tested them against local conditions and multiplied them for sale to their neighbors. As a result, by the late nineteenth century, a private seed industry was emerging in the United States -- the American Seed Trade Association had been founded in 1883 -- as was a flourishing private horticultural industry, members of which had formed the American Assocation of Nurserymen, in 1875.

Both seedmen and horticulturalists were acutely aware that the facts of biology made their intellectual property vulnerable to piracy and fraud. With sexually reproducing food plants, farmers could harvest the seed from one year's crop and plant it the next (in 1915, for example, farmers themselves produced 97% of the seed they sowed for wheat).[6] New varieties of many fruit trees, shrubs, vines, or flowering plants could be reproduced asexually -- that is, like roses, from cuttings or grafts. Thus, developers of such plants had no natural control over the reproduction of their property once it was sold. In a few years a new plant or tree could be anybody's plant or tree. Fraud arose from the facts of human nature: unscrupulous dealers might sell plants or seeds under false labels. The facts of biology helped make such fraud possible because it was difficult to determine whether a plant or seed was truly what it was represented to be or was a degenerate form taken from the progeny of an original variety. In 1896 Fruit Grower Magazine railed against "Injustice to New Fruits," and said many plant breeders were leaving their "patient toil" for lack of encouragement.[7]

Plant breeders sought to protect their interests through a variety of private arrangements. The simplest, which assumed that the breeder would obtain no market control over succeeding generations of his plant, amounted to selling the first new varietals at a high price (according to one report, a "good-sized fortune" might be paid for half a dozen new strawberry plants). Luther Burbank once declared that, although he would prefer the widespread testing of all his new fruits and flowers, such a practice would "be a perilous risk or utter ruin to the originator, as a single bud or seed in the wrong hands may place an unscrupulous person on an equal footing with the originator" in the market. He added, reflecting on the plight of the private breeder, "Having no Government aid or even protection, or college endowment to back us and to pay our bills, we must receive early returns, in part at least, for our tremendous expenses."[8] The more complicated arrangements imposed contractual obligations upon the purchaser -- for example, an agreement that he would neither sell nor give away grafts or cuttings, and the posting of a bond that provided surety of compensation if he did. Stark Brothers compelled such an agreement and bond from every farmer who bought a Delicious apple seedling.[9]

The passage of the federal Trademark Law in 1881 provided plant and seed developers a means to protect their intellectual property against fraud. A trademark could be any adjective or symbol -- for example, "Star" or "Majestic Beauty" -- or a company name such as Burpee.

Obtaining a trademark required merely registration of a word or stylized drawing, though the trademark had to be actively used to be legally maintained. The company name was the most valuable type of trademark, since it signified the firm offering the product, including its reputation for quality, rather than the size, color or type of the product itself, and could be employed only by the company registering it. Perhaps the most important inspiration to breeders in the appropriation of trademarks for plant protection was the Stark Brothers Nursery, in Louisiana, Missouri. In 1892, first prize at the Stark Fruit Fair -- an annual competion that the firm held to obtain new varieties -- went to an apple with a glossy red color that, so the story goes, proprietor Clarence Stark bit into and exclaimed, "Delicious! That will be its name." Stark tracked down the source of the apple, bought sole rights to the tree, which he surrounded with a tall metal fence, and trademarked the fruit as the "Stark Delicious" apple.[10]

Yet trademarking protected only the name: It did little to defend the breeder against the fact that the same rose by any other name might be marketed to smell as sweet. In short, trademarking did not protect a breeder's rights in a particular plant or fruit as such. For that reason, the development of the plant and seed industries was accompanied by a demand for protection of the breeder's intellectual property, particularly through the patent system.

The American patent system rests on Article I, Section 8 of the United States Constitution, which empowers the Congress "to promote the Progress of Science and useful arts, by securing for limited Times to . . . Inventors the exclusive Right to their . . . Discoveries." Congress had been quick to use its power, laying the foundation of American patent law in a statute that it enacted in 1790 and amended in 1793. Inventors were given exclusive rights in their inventions for fourteen years, a period drawn from British practice, which was based on the estimated time required to train two sets of apprentices, one after the other, in a new technique. (The American period was extended to seventeen years, in 1861, a compromise between the original fourteen and the twenty-one years that, after 1836, was allowed in exceptional cases.) But in granting the monopoly right, society struck a bargain with the inventor, compelling her to forgo secrecy. Indeed, the term "patent" derived from the phrase "letters patent" -- "open letters" -- meaning that in return for the protection of an exclusive right, the inventor had to disclose the details of his invention publicly so that other inventors, knowing its workings could try to improve upon it.[11] The 1793 amendment defined, in language written by Thomas Jefferson, what was patentable: "any new and useful art, machine, manufacture, or composition of matter, or any new or useful improvement thereof." At the turn of the century, Jefferson's phrasing remained at the core of the U.S. patent code (as it does today, except for the eighteenth-century word "art," which was replaced in the 1952 Congressional overhaul of patent law by the word "process").[12]

However plant patenting was legally discouraged in 1889, when the U.S. Commissioner of Patents upheld an examiner's rejection of an application for a patent to cover a fiber identified in

the needles of a pine tree. The examiner had argued that the fiber was unpatentable because it was undistinguishable from any other fiber. The commissioner transformed the reasoning into a landmark doctrine, noting that ascertaining the composition of the trees in the forest was "not a patentable invention, recognized by statute, any more than to find a new gem or jewel in the earth would entitle the discoverer to patent all gems which should be subsequently found." The Commissioner added that it would be "unreasonable and impossible" to allow patents upon the trees of the forest and the plants of the earth. As a result, it became a fundamental tenet of patent law that, in general, no protection could be obtained for products of nature, either inanimate or living. While the processes devised to extract what was found in nature could be patented, objects discovered there could not. They were not inventions, nor could they as a class be made anyone's exclusive property.[13]

In 1891, in a report to the American Association of Nurserymen, the respected plant scientist Liberty Hyde Bailey, of Cornell University, added technical weight to the legal discouragement. Two years earlier Bailey had told the nurserymen that an obstacle to any type of intellectual property protection for plants was that new types of plants were difficult to define or specify. Now he pointed out that most new varieties were accidents that the nurseryman found rather than the product of systematic breeding, adding, however, that "when the time comes that men breed plants upon definite laws and produce new and valuable kinds, then plant patents may possibly become practicable."[14]

The rediscovery of Mendel's laws at the turn of the century encouraged breeders to think that the era of controlled plant innovation had come to pass. Indeed, the power of Mendel's laws was invoked by one Hyland C. Kirk, a horticultural spokesman, when he appeared as the principal witness before the House Committee on Patents when it held hearings to consider the 1906 bill to establish intellectual property protection for plants. The measure, originally aimed at strengthening plant trademarks against infringement, had been revised to allow patents for horticultural plants, trees, and vines. Advancing a claim that would be repeated frequently in the debates over plant patenting, Kirk declared that the originator of a "new variety of plant, tree, or vine . . . is as truly an inventor and, as such, as justly entitled to protection as the originator of a new motor, a new chemical compound, or any other valuable combination of materials requiring experiment, deliberation, and design."[15]

Nevertheless, the bill died in committee. Evidently, few Americans considered breeding distinct enough from the practice of farming to warrant special protection. Farmers and horticulturalists might find innovation in the field in the form of plant sports or mutations that might be exploited. (Stark Brothers also continued to find bonanzas in the mail, notably the yellow apple that arrived at the nursery in a box one day in the spring of 1914 and that they soon marketed as the Stark Golden Delicious.) Both breeders and farmers continued to benefit from the

importation of new plant varieties from abroad and from the expanding activities of public breeders in the agriculture department and state universities, colleges, and experiment stations. Then, too, by practice and tradition, farmers assumed that they should enjoy free and unencumbered access to new seed varieties. And urban Americans probably tended, like Europeans, to think of food as a scarce resource and to be reluctant to grant anyone a monopoly right over food products, even for a limited period.[16]

Although an immediate failure, the 1906 venture did lead to the formation of a lobbying group, the National Committee on Plant Patents, which was organized and kept alive by Archibald Augustine of Augustine Nurseries in Bloomington, Illinois. By the late 1920s, nurserymen were especially interested in patents, not least because the potential American market for their stocks was estimated -- according to a report delivered to the 1928 convention of the American Association of Nurserymen -- at one billion dollars, almost entirely on the ornamental side.[17] When Augustine was elected president of the American Association of Nurserymen in 1929, he was succeeded in the chairmanship of the National Committee by Paul Stark, who was happy to invigorate the movement for plant patenting.

Stark was a principal in the Stark Brothers Nursery, which was now a century-old and, capitalized at one million dollars, was the largest breeder in the country. Stark brothers continued to derive some of its stock by running competitions for prize fruit specimens, but it also relied on more consistent sources, notably Luther Burbank.[18] Paul Stark had met Burbank in 1893, when Burbank was worried about making enough money to continue his research. A friendship and business arrangement blossomed. Stark Brothers came to own exclusive licenses to many of Burbank's cultivars. When Burbank died, in 1926, his will stipulated that his farm, in Santa Rosa, California, be converted into the Stark-Burbank Research Laboratories and Experimental Grounds. Stark thus inherited hundreds of varieties of plums, peaches, apples, cherries, pears, roses and gladiolas that had never been marketed -- and that might be patented, if patent protection were available. It was Stark, who, at the behest of the president of the American Association of Nurserymen, became the prime mover behind the 1930 Plant Patent Act.[19]

Stark himself drafted the measure. It was introduced in the Senate by John G. Townsend, Jr., of Delaware, who probably knew Stark and certainly had reason to sympathize with his purpose, since he owned 130,000 acres of apple orchards, which made him the second largest orchardist in the country.[20] Endorsements of the bill rained down upon the Congress from horticulturalists, nurserymen, farmers, agricultural experiment stations, and their organized representatives, including the American Farm Bureau Federation, the National Grange, the International Appleship Association, and the Peony and Iris Association. Thomas Edison wired that Congress could do nothing better for American agriculture than "to give the plant breeder the same status as the mechanical and chemical inventors now have through the patent law." Luther Burbank's

widow sent a telegram of her own declaring that her late husband would have been "unable to do what he did with plants had it not been for royalties from his writings and from other by-product lines of activity" and declared that most other plant developers were unlikely to derive such ancillary revenues from their work.[21]

In brief hearings, perfunctory floor debate, and the reports on the bill, its Congressional promoters noted the considerable dependency of plant breeding and research on governmental money, emphasizing that the establishment of a breeder's legal right in his innovations might stimulate private investment in these activities and make it possible for the breeder to reduce his prices. They pointed to the incentives that patent protection would give plant breeders to develop varieties resistant to blight and disease and rich in food or medicinal qualities; varieties that would strengthen public health, prosperity, and national defense -- and all without the expenditure of federal money. With sentimental nods to Luther Burbank, who was said to have made no money from his plants, the bill's enthusiasts promised that it would rescue plant breeders from vulnerability to piracy and the fate of an impoverished death.[22]

In these first few months of the 1930s Depression, the measure appealed as a farmer's and plant breeder's relief bill, Hoover-Republican style. With Republicans still in control of the Congress, the prevailing wisdom around Washington about how to respond to the worsening economic slide was: encourage private enterprise, reduce government costs and activities. There was only scattered opposition to the bill, including some biting harassment from Congressman Fiorello Laguardia, who was hazy in his understanding of heredity in plants but who understood well that the measure did nothing for direct farm relief. The Plant Patent Act passed easily on a voice vote some three months after it had first been introduced. Edison cheered in The New York Times, "Luther Burbank would have been a rich man if he had been protected by such a patent bill."[23]

In a report on the bill, the House Committee on Patents, mindful of the product-of-nature doctrine, had addressed the constitutionality of the measure, asking: Would a new variety of plant be a discovery, and could its originator be considered an inventor or a discoverer? The report's answer: Yes, on both counts. In the reasoning of the document, while a new variety of plant found in the field was a product of nature and, hence, not patentable under the meaning of the word "discoveries" in Article I, Section 8, a new variety arising from cultivation was such a discovery -- and its cultivator a discoverer -- since it was created by human agency. The report saw no difference between "the part played by the plant originator in the development of new plants and the part played by the chemist in the development of new compositions of matter." Both took the materials of nature, exploited its laws, and, applying a variety of techniques, devised a new and useful product.[24]

However, at this stage of history, chemical products and plants differed from each other in ways that affected the type of patent protection that plants could obtain. Patent law insisted that an invention be disclosed specifically enough to be identically reproducible. Chemical products, as dead matter, were highly specifiable as to composition and methods of production and reproduction. Plants, as living matter, were difficult to specify in either regard. These differences were reflected in the Plant Patent Act, which accommodated the basic tenets of patent law to what we may recognize as the problem of biological specificity in intellectual property protection. The act limited patent protection to those plants that could be reproduced asexually. Often termed cloning, asexual reproduction could be accomplished by budding, grafting, rooting of clippings, or division of bulbs; it yielded progeny genetically identical to the parent plant or tree.

The act also explicitly excluded from patentability tuber-propagated plants -- a provision that would substantially affect only Irish potatoes, which was a major cash crop, and Jerusalem artichokes, a type of sunflower that was widely used as a vegetable and a livestock feed. Resistance to allowing monopoly control of any type over major food stocks may have figured in the exclusion. However, to advocates of plant patenting, authorizing patents on tuber-propagated plants like the Irish potato threatened the enforceability of plant patents in general, mainly because the part of them that is involved in reproduction is also widely sold as food. Paul Stark later explained the reasoning behind the exclusion: Because potatoes were available everywhere "for use as food or for growing the plants," infringement of a potato-plant patent would be "easy" and "widespread," making enforcement "a farce." He added, "This would reflect unfavorably on enforcement with the other types of asexually reproduced plants -- so for that reason potatoes were excluded from the original Plant Patent Act in 1930."[25]

Stark and his allies had perceived an equally vexing enforcement problem for patents on sexually reproduced plants. Such plants could not generally be relied upon to breed identically true to type from one generation to the next. (Sexual reproduction joins half the genes from one plant with half from another; over several generations, the progeny can easily drift genetically far from the original parental type. Indeed, the business of plant breeding was fundamentally a battle to limit genetic variability through succeeding generations, since farmers expected the seeds they bought to yield roughly similar plants.) Patents on sexually reproduced plants could not be enforced because the progeny would be different from the patented parent. The likely unenforceability prompted a special committee of the American Society for Horticultural Science to oppose flatly the provision of patent protection for seed-propagated plants, and it convinced key members of the Patent Office and the Department of Agriculture that no bill with such a provision could pass.[26] The Congressional stewards of the bill, although they may not have understood the genetics, were evidently sufficiently aware that like did not necessarily breed like

to omit from the final measure protection for plants that were reproduced sexually.

Despite the restricted coverage provided by the act, it was a boon to breeders like Paul Stark. While narrow, the category of asexually reproducible plants was capacious enough to include much of such breeders' stock in trade -- that is, virtually all fruit and nut trees; most small vinous fruits such as grapes, strawberries, and blueberries; and numerous ornamental shrubs, vines, and perennials, among them lilacs, wisterias, and peonies as well as roses.[27] According to The First Plant Patents, a survey published in 1934 by a New York patent lawyer named Robert Starr Allyn, the government had granted eighty-four plant patents by the beginning of that year, including one to Secretary of the Interior Harold L. Ickes, for a red dahlia. Nine of the patents went to Burbank's estate for certain of his fruits and flowers. His widow assigned the patents to Stark Nurseries, which acquired rights to an additional five from other breeders.[28]

Since the wares of seedmen comprised sexually reproducing plants, the act disappointed the American Seed Trade Association, which had allied itself with Stark in the plant-patent legislative drive. Stark defended the omission of sexually reproduced plants from the coverage of the act, telling the association that "it seemed to be the wise thing to get established the principle that Congress recognized the rights of the plant breeder and originator," predicting that once the principle was in place, it would be "much easier" to get protection for plants propagated by seed.[29]

However, while the act installed the principle, the intellectual property protection it provided was no better than the degree of biological specificity -- which was to say the least limited -- with which plants could then be identified. The act was extremely permissive in inventive definition, allowing patents on plants, even naturally occurring ones, that might be no more than minimally distinguishable from others, so long as human intervention had been required to reproduce the plant asexually. Its disclosure requirements, adapted to the category of living inventions, were also, of necessity, loose. They called for the submission of a color painting or photograph as well as a written description of the plant that was as "complete as is reasonably possible." They called for an historical preamble describing how the plant was bred or where the sports from which it was asexually reproduced had been found, and how it differed from the plants that comprised its pedigree. They asked for data concerning when the plant bloomed and which soils and climates best suited it. They expected a technical description outlining the color and shape of the bush, leaves, and flower.[30]

The early applications included a few objective descriptions -- for example, lengths and the tones listed on Ridgway's Color Chart, a commercially manufactured set of cards, much like paint-sample cards, that breeders held against a plant to identify and match a name to its colors. it. Fruit, which was described by external appearance, might be specified by such intrinsic characteristics as acidity and sugar levels.[31] The written descriptions advertised the commercial

identity of the plant because breeders had to supply a name for the new cultivar -- usually it was a fancy one, like Delmass Peach or Peace Rose. Otherwise, the descriptions were generally imprecise enough to undermine the bargain that a grant of intellectual property protection would be accompanied by a degree of disclosure that would permit others in the art to improve upon the invention. The information in the descriptions was, in fact, of little use to other breeders, precisely because living plants were difficult to specify as invented or inventable matter.[32]

Given the relaxed nature of the disclosure requirements, critics questioned whether the Patent Office would be able to administer the act so as to distinguish genuine from counterfeit intellectual property. Their doubts were perhaps accentuated when the first examiner assigned to plant patents proved to be not a botanist but a mechanical engineer who was also charged with oversight for "Closure Operators, Fences, Gates, Tillage and Handling Implements." After a year, Herbert Hoover ordered the Department of Agriculture to assist the Patent Office. The first plant patent -- on a rose called the 'New Dawn' -- confirmed the critics' fears. An amateur gardener had found a bud mutation on the 'Van Fleet' rose, which had been painstakingly developed by an established breeder, that supposedly extended the life of the flower. Save for this "everblooming" quality, the New Dawn was identical to the Van Fleet. Most patents were issued to amateur gardeners who, finding sports and mutations on well established cultivars, assigned them to large nurseries.[33]

Robert C. Cook, the editor of the Journal of Heredity, feared that plant patents would become the conceits of amateur gardeners rather than real protection for professional breeders. In the hope of making plant patents more like industrial patents, he proposed "type plants" as in situ deposits, much as the patent office in the 1800s had demanded patent models when written descriptions were inadequate.[34] However, the imprecise disclosure of the plant patent application limited the protection that the federal government could offer to patent holders. In practice, the Plant Patent Act only prevented unauthorized advertising by the patented name. It functioned more as a registration system than as the kind of rigorous examination and screening system characteristic for industrial inventions. Because the descriptions of patented plants were so poor, the cornerstone of most case law surrounding the act was not whether an alleged infringer's plant looked like a patented one but whether it could be proved to have been cloned from it. The definition of the inventive act was that a plant, even one found in the wild, had been asexually reproduced, in a sense reduced to practice. Many applications jointly listed the discover and the reproducer. All the breeders really got from the act was the ability to use a tradename and a legal basis for infringement suits. The weakness of the protection provided by the Plant Patent Act was perhaps revealingly expressed by the small number of patents issued under it -- 911 in the 20 years following its passage.[35]

The seedmen may have been disappointed, but perhaps not too much so, since they had been developing alternative methods of intellectual property protection, notably seed certification. In the late nineteenth century, state agencies had assessed seeds for both purity and performance, some times writing scorecards based on visual appeal for crops submitted at county fairs. At the turn of the century, the agencies began to measure varietal yields through actual grow-out tests, the winners advertising their blue ribbons. However, farmers who bought the seed saved it each year and sold it to their neighbors, polluting markets with adulterated seed. Reputable seed dealers asked the stations to certify the genetic purity of their seeds by tests showing statistically that a bag of seed would grow into the plant promised with good uniformity, germinability, and without weeds. In 1919, state agencies inaugurated certification programs, publishing lists of recommended varieties and sometimes refusing to certify "new" varieties that lacked a marked improvement in performance over varieties that were already certified.[36]

While many state agricultural departments successfully imposed standards of seed quality within their state borders, they had no authority to prevent the importation of low-quality seed from other states. That deficiency led to the passage of the 1939 Federal Seed Act, the primary purpose of which was to permit the imposition of standards of seed-quality on seeds sold in interstate commerce.[37] Seed certification, now national, not only defended consumers against unreliable seed; it also safeguarded quality seed products from the competition of less worthy alternatives -- and thus protected the intellectual property investment that produced the quality.

The Federal Seed Act required that certified seed be sold only by variety name rather than by brand name. Now all seed in a given variety would be sold by one name, with a blue tag on the bag indicating that the federal government backed the purity of the contents. In many states, large seed firms had sold their certified seed packets under brand names and, in the interest of quality control, had performed free germinability tests. The act eliminated the incentives of these dealers to demonstrate that they met standards of certification: since there could be no product differentiation on certified seed, there was no point in demonstrating quality in seed multiplication. Prices on certified seed rapidly levelled to close to the cost of production. However, state agencies usually studied a new variety for five years before deciding to offer certification tests for it, which gave breeders a window of opportunity for introducing and exploiting new varieties under trademark names. By the late 1950s, more seed was sold under trademarks than as certified seed.[38]

Yet for commercial breeders, the most tantalizing method for protecting intellectual property in plants came from biology itself -- through the exploitation of hybridization as it worked in the paradigm case of corn. Hybridized corn involved double-crossing from strains inbred to accentuate particular traits -- for example, the height of the ear, stalk strength, disease resistance. The seeds from the double-cross produced exceptionally vigorous crops, but if the seeds from the

crop were planted, yields would fall substantially. Hybridization thus protected the intellectual property of breeders -- the property itself resided in the germ plasm of the inbred strains, which could be kept a closely guarded secret -- through biological means, forcing farmers to buy new seed each year.

In 1919, Edward M. East and and Donald F. Jones, two of the principals in the development of hybrid corn, pointed out the intellectual property advantages in the double-cross method that produced it:

> It is not a method that will interest most farmers, but it is something that may easily be taken up by seedsmen; in fact, it is the first time in agricultural history that a seedsman is enabled to gain the full benefit from a desirable origination of his own or something that he has purchased. The man who originates devices to open our boxes of shoe polish or to autograph our camera negatives, is able to patent his product and gain the full reward for his inventiveness. The man who originates a new plant which may be of incalculable benefit to the whole country gets nothing -- not even fame -- for his pains, as the plants can be propagated by anyone. There is correspondingly less incentive for the production of improved types. The utilization of first generation hybrids enables the originator to keep the parental types and give out only the crossed seeds, which are less valuable for continued propagation.

According to the later testimony of Paul Stark, when in 1930 the Congress was considering the Plant Patent Act, seed-corn breeders thought they might get better and quicker protection from hybrid corn than from plant patents.[39]

When introduced to Illinois in 1929 hybrid corn seeds yielded only slightly more ears of corn than naturally open-pollinated varieties. Yet between 1932 and 1936 the percentage of Illinois cornfields planted with hybrid seed rose from scarcely 1% to over 75%. Illinois farmers were encouraged to believe that hybrid corn was technically superior to open-pollinated varieties largely because a handful of large seed dealers -- notably Pioneer Hi-Brid Corn Company, Funk Brothers Seed Company, the DeKalb Agricultural Association, and Pfister Hybrid Corn Company -- encouraged them to do so, aided by the scientific authority of government agricultural institutions. (Hybridized corn decidedly advantaged large seed firms, those with the land to raise a wide variety of inbred strains as well as the manpower to test the crossing.) Breeders physically cloistered their plots of inbred strains with barbed wire and armed guards. Only top management was privy to the pedigree sequence. By 1950, following years of research investment by private breeders, the yields of hybrid corn far exceeded those of open-pollinated corn.[40]

Paul Stark remembered that in 1930 breeders of seed plants had been as optimistic as the seed-corn men about obtaining intellectual property protection from hybrid methods. And in the 1940s and 1950s, major breeders of seed crops such as wheat sought in hybridization the kind of intellectual property protection it had given their counterparts in corn. Besides, in the immediate

postwar years, the devastation in Europe and foreign aid programs made an assured market for the export of U.S. agricultural products, innovative or not. If for more than thirty years following the passage of the Plant Patent Act there was no drive for the legislative extension of patent protection to sexually reproducing plants, it was very likely because the lure of hybridization joined with the system of contracts, bonds, certifications, and trademarks to make additional intellectual property protection seem unnecessary.

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The seedmen's apparent satisfaction with the status quo through the postwar decade turned to increasing dissatisfaction by the 1960s. The reasons for the shift are circumstantial but clear enough. The basic textbooks on plant breeding of the day suggest that the high expectations for hybridization were falling far short of realization. While hybridization had succeeded with onion, sugar beets, and sorghum, it had failed with a number of other plants, notably wheat.[41] Nor had there been any dramatic breakthrough in breeding methods. However, an accumulation of different biological methods, many of them adapted from cytological genetics, had added considerable power to the effectiveness of conventional breeding, forming a new arsenal for improving plants and maintaining the stability of varieties. The methods included speed breeding with backcrossing that allowed, for example, the development of varieties of oats resistant to rust in seven years instead of ten; very large-scale selection programs that yielded an abundance of advantageous strains; the induction of polyploidy to manipulate desirable plant characters such as quality and hardness, and of monosomy as well as nullisomy to identify linkages between characters and chromosomes.[42]

The Green Revolution fostered by the work of Norman E. Borlaug was moving into full fecundation, transforming the productivity of Third World agriculture by the introduction of new varieties in conjunction with the use of chemical fertilizers. (Borlaug would be awarded the Nobel Peace Prize in 1970 for his achievements.) His work added credibility to a claim that plant breeders were increasingly advancing about the relationship between intellectual property protection and the world's food supply. If historically there had been a cultural assumption that grants of monopoly incentives, even temporary ones like patents, might threaten the availability of food, by the early 1970s breeders were doing their best to reverse the assumption. Of course, Borlaug 's innovative breeding program had been carried out in Mexico with the support of the Ford and Rockefeller Foundations and Borlaug acquired no intellectual property protection in the resulting plants.[43] No matter to private plant breeders: In their increasingly common argument, the grant of temporary monopolies in the development of new plants would make the world's food still more abundant by calling forth still more plant innovations.

Renewed attention to intellectual property protection also no doubt came from the burgeoning of the domestic seed market and seed industry. In constant 1967 farm dollars, seed sales had jumped from about $85 million in 1940, to $445 million in 1950, to $611 million in 1965.[44] While hybrid corn sales had likely led the way, the later surge, perhaps a consequence of the transformation of agriculture into agribusiness, probably expressed rising demand for other types of seeds. Borlaug's success also indicated that considerable profits might be derived from the development of plant varieties for Third World markets.[45] Yet European agriculture, fully recovered from the devastation of the war, had returned to the international markets as a vital competitor. And coming to fruition was a move by the European nations, begun in the 1950s, to establish a uniform system for the protection of plant breeder's rights.

European plant breeders had traditionally been eager -- perhaps more so than their American counterparts -- for strong intellectual property protection, since the similarity of growing conditions in the several European states made plants developed in one nation commercially exploitable in another. Laws and regulations governing the protection of intellectual property in plants mirrored the types of protection that had developed in the United States -- patents, certification, trademarks, and contractual arrangements -- but also included systems of plant variety protection. Such systems protected intellectual property in a new variety that was distinct from others as well as uniform and stable in the characteristics that made it distinct. Like a patent, plant variety certificates let the breeder exclude other seedsmen from profiting from his creation for a period of seventeen years, but, reflecting the special attitudes towards natural products, it also constrained the rights of the breeder so as not to disadvantage farmers or jeopardize the food supply.[46]

Whatever the mixture, the means of plant property protection varied considerably from one European state to the other, the principal distinction falling between plant patents and the variety certificates. Denmark explicitly excluded plants from patentability and Britain did so de facto. The Netherlands and France hewed to varietal protection, resisting plant patents, while Germany and Italy allowed them.[47] In the past, the European states had tried intermittently to establish an international plant protection system that would encourage some uniformity in intellectual property schemes across the different states. The eagerness to accomplish that purpose no doubt increased in the 1950s as Europe began to move towards an economic union that would eliminate national barriers to competition in agricultural products.

In 1952, at the Vienna Congress of the Association Internationale pour le Protection de la Propriete Industrielle, the major trade association for intellectual property law, the German delegation advocated complementary plant patent and plant certification systems. The Germans proposed that the Convention of Paris for the Protection of Industrial Property, which had been adopted in 1883 and which in successive versions had endorsed the protection of living products

in principle, be amended explicitly to allow the patentability of plants of ensurable reproducibility and industrial-like applicability. The German group also urged the establishment of a parallel system of "protection for varieties of plants, for which less exacting requirements regarding novelty and degree of invention should be applied."[48] The Association declined to act on the German proposal in 1952 and, again, at its Brussels meeting in 1954. (Indeed, the Strasbourg Convention, a European agreement on patents adopted in 1963, would declare that member states would "not be bound" to grant patents on "plant or animal varieties or essentially biological processes for the production of plants or animals.")[49]

In the meantime, the plant breeders took their cause elsewhere --to the principal European breeders' trade group, the Association Internationale des Selectionneurs pour la Protection des Obtentions Vegetales. In 1957, prompted by the association, the French government hosted a conference on plant breeder's rights to which nine governments sent delegations. The agenda for the meeting, circulated by the French, strongly implied that, in the view of the conveners, the creations of plant breeders were so unlike industrial inventions as to be fundamentally inappropriate for patent protection. That view prevailed at the conference and in the succeeding deliberations of a Committee of Experts that the conference, at its close, agreed to examine the legal issue of breeder's rights. In 1960, in its final report, the committee concluded that plant protection required the establishment of a convention separate and distinct from the existing Paris Convention on Industrial Property. Thus, in Paris, on December 2, 1961, an International Conference for the Protection of New Plant Products adopted its own Convention of Paris, which formally created the Union International pour la Protection des Obtentions Vegetale (UPOV).[50]

Following existing national plant variety protection laws, UPOV required member states to provide the option of intellectual property protection for at least fifteen years on plant varieties that were distinctly new, homogeneous, and stable. It allowed the states to grant patents on plants but not to give double protection -- that is, a patent and varietal right in the same plant. The UPOV regulations also expressed recognition of the differences between the stuff of industrial patents and living matter -- particularly that disclosure of the essential characteristics of living matter was, in the case of plants, a meaningless requirement and that such matter could be of vital importance to human survival. Instead of disclosing their plant innovations, breeders had to submit them for testing of their distinctiveness, uniformity, and stability. They also had to maintain the plant throughout the period it was protected. Furthermore, the intellectual property protection granted in the plant was not to prevent other breeders from using it without authorization to develop new varieties of their own. And the exclusivity of the protection had to yield to compulsory licensing -- with due compensation -- if some public interest required use of the plant.[51]

UPOV's provisions were highly specific, and, unlike the Paris Convention on Industrial Property, which was relatively lax in its demands on member states, UPOV required that its member states conform to them. To become effective, UPOV had to be ratified by at least three states, and the process of conformation took some time. UPOV finally entered into force in 1968, when it was ratified by the Federal Republic of Germany, the Netherlands, and the United Kingdom. By 1977, the signatories would also include Belgium, Denmark, France, Italy, and Switzerland.[52]

In the United States, on 21 February 1967, Senator John L. McClellan, of Arkansas, chairman of the Senate subcommittee concerned with patents, introduced S. 1042, a bill from President Lyndon Johnson's administration for a general revision of the patent laws that aimed, in part, "to harmonize U.S. practice with that of other nations as a step toward closer international cooperation and increased international trade." American seedmen, well aware of the creation of UPOV and its provisions, urged that McClellan's bill be amended to add the phrase "or sexually" to the 1930 Plant Patent Act, thus extending patent protection to seed-propagated plants.[53]

Secretary of Agriculture Orville L. Freeman also objected, contending that patent protection for seed-propagated plants would undercut his department's longstanding programs of breeding plants for development and sale by seedmen and nurserymen, particularly by jeopardizing "free and uninhibited communication among breeders, both public and private." He also warned that his Department could not enforce such an act -- because "many varieties of crop plants exhibit a change in genetic composition from year to year, so that a variety, in a few years would no longer fit the description of the basis on which it was patented." The problem of unenforceability was also emphasized to McClellan's subcommittee by Paul Stark himself, who not only recalled its importance in the 1930 rejection of patents for seed-propaged plants but who gathered expert testimony from a number of crop scientists to argue that it was no less valid now. In Stark's opinion, seed-propagated plants merited some kind of intellectual property protection, but not in the same section of federal law that granted such protection to asexually reproduced plants. Opposition also came from the American Farm Bureau Federation, which declared seed certification programs sufficient safeguards for the interests of breeders of sexually reproducing plants.[54] The Federation, which spoke primarily for consumers rather than producers of seed, was one of the most powerful agricultural lobbies in the country.

However, since the 1930s the plant and seed industry had burgeoned in power and allies as well as sales -- had become a part of agribusiness -- and it had more of a stake in intellectual property protection. In a letter to McClellan on behalf of the American Seed Trade Association and the National Council of Commercial Plant Breeders, John I. Sutherland, the executive vice president of the seed group, pointed out that twenty years earlier very few proprietary varieties had been released by seedmen because the agriculture department and experiment stations had

been breeding and releasing the new varieties. Sutherland added that seed companies had invested in research staff and facilities and produced proprietary varieties that were superior to public varieties and bred true. These developments had reduced the need for public investment in varietal research and for an increase in protection for private investment in new plants. Sutherland noted that "many large associations are 100% in favor of this amendment," citing as examplary evidence a resolution of the National Canners' Association and endorsment from the American Association of Nurserymen. Paul Stark obviously no longer represented the nurserymen: His crop-science experts comprised primarily faculty at state universities and experiment stations -- public breeders.[55]

While the proposed "or-sexually" amendment failed, the American Seed Trade Association managed to obtain the introduction in mid-1969 of a new bill -- an act for plant variety protection à la UPOV rather than by patents. In June 1970, at hearings on the measure --it was designated S.3070 -- in the Senate Committee on Agriculture and Forestry, Senator B. Everett Jordan, of North Carolina, managed to take testimony from fifteen witnesses, all from the seed industry, in fifty-five minutes. Jordan declared, "I do not think that I have ever held a hearing that was more more for one side than this one." On 21 August 1970, S. 3070 was reported out of that committee and sent for review to the Subcommittee on Patents and Trademarks of the Senate Committee on the Judiciary, which found that it did "not alter protection currently available within the patent system." On October 2, 1970, the Senate took up S. 3070 as "an unobjected-to item" and passed it without a recorded vote.[56]

In the House, Congressman Robert Kastenmeier, a Democrat from Madison, Wisconsin, whose district included the state university and a large number of farms, objected to the notion of plant breeder's rights, insisting that the country had done just fine without it. Furthermore, as chairman of the Judiciary subcommittee that was involved with patents, he was concerned about how the adminstration of the act would be financed, which question virtually monopolized the succeeding hour of floor debate on the bill.[57] The bill, slightly amended to deal with how fees collected in administering the act would be handled, passed on a voice vote on December 8, 1970 and, on December 28, President Richard M. Nixon signed it into law.[58]

In its main features, the Plant Variety Protection Act was a product of the UPOV model refracted through the demands of relevant American interest groups. It established a system of breeder's rights to be administered by the Plant Variety Protection Office (PVPO) at the Department of Agriculture headquarters in Beltsville, Maryland. The rights were given the form of Plant Variety Protection Certificates (PVPCs) to be issued for seventeen years to new varieties that are distinct, stable, and uniform. Any plant could qualify, except the so-called "soup vegetables" -- tomatos, okra, peppers, carrots, cucumbers and celery -- which were excluded from coverage at the urging of the Campbell Soup Company. Campbell feared that the PVPA

would increase the costs of these vegetable and close off sources for hybridization programs, perhaps its own.[59]

Breeders would apply for a protection certificate by submitting a written description of the plant. The PVPO was to provide a list of roughly 500 descriptors for each class of plant, requiring the applicant to disclose much more data than applicants for plant patents. Each applicant's data would then be tested for distinctiveness against similar data compiled from other applicants and existing public varieties already described in seed trade journals. Breeders were also required to deposit 2500 seeds, to be kept viable for the period of the certificate at a USDA gene bank in Fort Collins, Colorado, where the seed would be stored in refrigerated quart jars.[60]

While the PVPO computerized data base would test for distinctiveness, it was assumed that the seedmen themselves would assure uniformity and stability, since these characteristics were advertised as indicators of seed quality. Farmers paid a premium for seed that was "uniform" within a generation, and "stable" across generations. The PVPA was connected with the seed certification provisions of the Federal Seed Act; certificate holders could request that the government inspect their seed and certify the label on their seed packages. Also, breeders could register data on their varieties with the PVP Office and could sell their seed as quality certified without incurring the expense of applying for a plant variety certificate. Seed certification entailed using seed production and conditioning standards in combination with a system of record keeping and field and seed inspections by agents from the Department of Agriculture to protect the genetic purity and maintain the genetic identity of varieties.

Like the UPOV requirements, the PVPA provided for a research exemption, which allowed any researcher to use protected seed to develop new, distinct varieties. If necessary, the seeds could be drawn from the Fort Collins gene bank. Also like UPOV, the PVPA included a public interest exemption, authorized the secretary of agriculture to demand compulsory licensing and mandatory commercialization when the PVPC holder did not release a variety crucial to the health of the American economy. Farmers associations also insisted upon a farmer's exemption, allowing anyone to save and replant protected seed from year to year so long as the person's primary business was not reproducing seed for sale.[61]

The act stipulated that breeders could disseminate seeds for testing without jeopardizing their claims to priority. Verifying the utility of a new variety took many years and required that seed be widely disseminated to various grow-out plots owned by different companies. To qualify for the testing exemption, the breeder needed to submit a PVPC application to register the variety name, and then to label all bags of seed. However, these requirements also controlled the purity of the seed at each step in the multiplying process. In that way, the PVPA offered the same sort of intellectual property protection as a trademark. Farmers selling protected seed would make themselves obvious by advertising the protected name of the variety; and UPOV states would be

unable to do what they had long done -- sell American seed under a different brand name.[62]

* * *

The United States had not adhered to UPOV, primarily because of the convention's prohibition against double protection -- that is, both patent and varietal protection for the same type of plant. In the 1970s, eager to have the United States as a member, the UPOV countries negotiated a revision of the convention to accommodate the protections provided by the Plant Patent and Plant Variety Protection Acts. Adopted in 1978, the modified convention allowed, among other things, any member state to give both patent and varietal protection to the same genus or species of plant if both types of protection were in place before October 31, 1979, the deadline for signing the new UPOV text.[63] On October 28, 1978, the United States signed the convention, subject to ratification of its adherence by the American government and revisions of its plant variety protection law into conformity with UPOV requirements.

While closely following those requirements already, the PVPA departed from them in minor respects, particularly in granting its protection certificates for seventeen instead of eighteen years. An opportunity to obtain the necessary change arose in 1979, when Senator Frank Church, of Idaho, introduced a bill to accomplish certain "minor housekeeping" amendments to the act. Part of Church's cleanup concerned removal of the exclusion from varietal protection that had been granted to the six soup vegetables, The exclusion had prompted strong complaints from plant breeders, had redirected research in those vegetables in the hybrid direction, and now no longer interested the Campbell Soup Company. At the prompting of the Department of Agriculture, an additional bill was introduced by Senator Herman Talmadge, of Georgia, to extend the term of protection to eighteen years.[64]

Hearings on the bills, held in the House in June 1979 and April 1980, called forth a diverse range of opinions on intellectual property protection in plants, not all of it friendly. Similar unhappiness cropped up in some of the briefs that figured in the final round of *Diamond v. Chakrabarty*, which challenged the longstanding doctrine of the general non-patentability of living organisms and happened to reach the Supreme Court for argument in the middle of the Congressional deliberations on the PVPA.

The case had originated in 1972, when Ananda Chakrabarty, a microbiologist at the General Electric Co., had applied for a patent on a variety of bacteria that he had bred and engineered to break down most of the hydrocarbons in petroleum. The U.S. Patent Office had rejected his application for several successive reasons but chose to make its final stand on the ground that Congress had not authorized patent protection for any living organism other than the types specified in the Plant Patent Act. In the mid-1970s, Chakrabarty's claim became entwined with a

complementary case advanced by Malcolm E. Bergy and fellow scientists at the Upjohn Company, who had applied for a patent on a purified strain of a fungus that generated the antibiotic lyncomycin.[65] As with Chakrabarty's claim, the Board of Appeals in the Patent Office rejected that of Bergy et al because the fungus was alive, warning that a liberal interpretation of the patent code would lead to the patenting of "new types of insects, such as honeybees, or new varieties of animals produced by selective breeding and crossbreeding."[66]

In 1977, the fungus claim came to the U.S. Court of Customs and Patent Appeals, which ruled three to two in favor of Bergy. The majority opinion was delivered by Judge Giles S. Rich, who, before his appointment to the federal bench, in 1956, had distinguished himself as a patent attorney during some thirty years of practice in New York City and who manifestly recognized that, to a considerable extent, life was chemistry. Rich viewed it as "illogical" to allow patents for processes that relied upon the functions of living organisms but to deny patents to a living manufacture or new composition of matter as such. He contended that in their nature and commercial uses, biologically pure cultures of microorganisms were "much more akin to inanimate chemical compositions such as reactants, reagents, and catalysts than they are to horses and honeybees or raspberries and roses." He found nothing in the language of the patent laws that excluded such tools from patent protection solely on grounds of their being alive; it was being alive that made them useful. He held, "In short, we think the fact that microorganisms, as distinguished from chemical compounds, are alive is a distinction without legal significance."[67] When, in March 1978, the appeals court decided Chakrabarty's claim, a majority ruled similarly in his favor. Judge Rich, speaking for the majority, saw only one issue --- the patentability of living organisms. The Court had dealt with the identical issue in the Bergy case and found its reasoning there sufficient and controlling.[68] The case reached the Supreme Court because the Patent Office, dissatisfied, appealed it, in the name of Patent Commissioner Sidney Diamond, who formally contested only Chakrabarty because at the beginning of 1980 Bergy withdrew from the process.

The PVPA hearings and the arguments before the court revealed that by the beginning of the 1980s a coalition had formed in opposition to the enlargement of intellectual property protection in living organisms, including plants. The dissidents represented consumer organizations, small farmers and share croppers, public interest scientists, and the People's Business Commission, which was headed by the social activist and opponent of genetic engineering Jeremy Rifkin. During Chakrabarty, the People's Business Commission filed an amicus brief alleging to the Supreme Court that the Plant Patent and the Plant Variety Protection acts were directly responsible for a dangerous and steady reduction in the number of varieties cultivated in major food crops -- for example, the number of different strains of wheat -- and the resultant narrowing of each crop's genetic diversity. Many native strains of plants were being lost as

farmers replaced them with a few superior varieties. And the less genetically diverse a crop, the more susceptible it was to one or another disease. Indeed, in 1970, a corn blight had wiped out nearly fifteen percent of that crop in the United States, prompting a study by the National Academy of Sciences to note that "genetic uniformity is the basis of vulnerability to epidemics" and to add that "most crops are impressively uniform genetically and impressively vulnerable."[69]

According to the Commission's brief, the reduction in crop varieties was the consequence of plant patents (the brief casually lumped together under the term "patents" both the genuine patents established by the 1930 act and the weaker protection certificates provided by the 1970 act). In the brief's analysis, seed and grain companies bred only those plants that could be patented -- a small number, it held -- and then (somehow) persuaded farmers to buy and substitute them for native strains. Furthermore, a few large corporations -- frequently the same drug and chemical companies that were beginning to invest in biotechnology -- had been acquiring independent seed companies and their plant "patents" (protection certificates). For example, Upjohn, together with three other companies, now held 79% of such "patents" in beans. The overall result: "thanks to the patent laws, the bulk of the world's food supply is now owned and developed by a handful of corporations which alone, without any public input, determine which strains are used and how."[70]

In hearings on the PVPA, various witnesses raised the same issues and enlarged on them, attacking the acquisition of seed farms by large petrochemical companies, some of them European, warning that the trend would lead to concentrated industrial control over essential food resources. They blamed the trend for the fact that already average cost of seeds and shoots per farm had risen by 164% between 1972 and 1977, a greater increase than the rise in prices in all other farm inputs, including fuel. They charged that Third World countries were being supplied with plant varieties that, while high in yield, were also high in cost.[71] They contended that the number of new varieties released had declined since 1968 because, as Gary Nabhan, a conservation-minded botanist at the University of Arizona and the Arizona Desert Museum, testified in the PVPA hearings, "regional seed companies have been consolidated and bought up by multinational corporations that are not interested in diversity." Nabhan added that the extension of intellectual property protection to plants had also fostered breeders' secrecy, declaring that "since 1972, not a single private agribusiness breeder has published descriptions of breeding schemes or techniques for their new varieties in the section on "Cultivar and Germplasm Releases," a part of the magazine HortScience, the most popular outlet for such information among university and government breeders."[72]

The dissidents made little headway with the decisionmakers in either the Supreme Court or the Congress. On June 16, 1980, the Court held, by a vote of five to four, that Chakrabarty had a right, within existing statutes, to a patent on his microorganism. Chief Justice Warren Burger

delivered the majority opinion, which echoed much of the reasoning in the appeals court opinion of Judge Rich. Justice Burger enthused over the broad language that Jefferson had written into the patent law of 1793, calling it expressive of its author's "philosophy that 'ingenuity should receive a liberal encouragement'" and noted that all succeeding Congresses had left Jefferson's language virtually intact. Rejecting the contentions of the Patent Office, he found that the patent code as written was ample enough to accommodate inventions in areas unforeseen by Congress, including genetic technology, and to cover living microorganisms. Congress, in passing the plant acts of 1930 and 1970, had "recognized that the relevant distinction was not between living and inanimate things, but between products of nature, whether living or not, and human-made inventions." Chakrabarty's bugs were new compositions of matter, the product of his ingenuity, not of nature's. As such, they were patentable under existing law.[73]

During the Supreme Court's consideration of the case, the People's Business Commission brief had argued that, if patents on microorganisms were allowed, patents on higher life forms would soon follow. That claim had been earlier contested, before Judge Rich's court, by parties with a substantial interest in the patenting of life, including, notably, the University of California, which co-owned the patent on recombinant DNA and expected to collect royalties on organisms produced through the use of that technique. In its amicus brief, the University contended that at issue was only the patentability of "single-cell organisms which are mindless, soulless and brainless," not that of higher life forms. Judge Rich echoed that reasoning, taking note in his opinion of the fear that allowing patents for microorganisms would make patentable "all new, useful, and unobvious species of plants, animals, and insects created by man" -- and declaring the fear "far-fetched."[74] Writing for the majority of the Supreme Court, Chief Justice Burger took a more agnostic, though implicitly Rich-like position, on the congeries of apprehensions that surrounded genetic engineering. While acknowledging "that, at times, human ingenuity seems unable to control fully the forces it creates," he observed that genetic research with its attendant risks would likely proceed with or without patent protection for its products and that neither legislative nor judicial fiat as to patentability would "deter the scientific mind from probing into the unknown any more than Canute could command the tides." More important, the Court's task was the "narrow one of determining what Congress meant by the words it used in the statute" -- which the Court had done -- and once that was accomplished, its powers were "exhausted."[75]

In November 1980, the revision of the PVPA came to the floor of the House under the guidance of Congressman Eligio (Kiki) de la Garza, a Democrat from Mission, in the Rio Grande Valley, Texas, and vice chairman of the House Committee on Agriculture. Earlier, in the hearings, de la Garza had allowed that he did wonder how the protection of pepper plants might affect his "little chili patch"; even so, he had considered it unlikely that Congress would overturn the PVPA: "The fellow that came with his seeds -- a Johnny Appleseed walking across the plain.

We cannot go back to that, and without some form of protection you are back to the law of the jungle."[76] On the House floor, de la Garza argued that the PVPA had brought more private capital into improving plants, noting that "absent legal protection, private development efforts are often limited to the production of hybrid varieties." He contended that the PVPA did not encourage uniformity in crops, that, indeed, it encouraged the reverse, since to obtain a protection certificate the new plant had to be distinct from other varieties.[77] He pointed out, using data that apparently came from the Plant Variety Protection Office, that since 1970 "the number of new varieties has increased from 94 to 227 (141 percent) for soybeans, from 139 to 231 (66 percent) for wheat, and from 64 to 96 (50 percent) for cotton."[78] The bill to revise the PVPA swept through the House and the Senate on voice votes, with its soup-vegetable coverage and eighteen-year certificate term intact, and, on December 11, 1980, was signed into law by President Jimmy Carter. By 1983, following certain adjustments in UPOV regulations and the adminstration of the PVPA, the United States had become a full UPOV member state.[79]

While the dissidents lost on the major issue of intellectual property protection, they did stimulate concern in the Congress about whether the PVPA might, as Representative Shirley Chisholm, a liberal Democrat from Brooklyn, New York, put it, "be contributing to future food disasters in an increasingly hungry world."[80] Senator Patrick Leahy, a Democrat from Burlington, Vermont, with a strong interest in agriculture, read a letter into the Congressional Record that asked Secretary of Agriculture Robert Bergland to initiate a study of germplasm storage and the general effect of the PVPA on "increasing concentration in the seed trade industry, loss of genetic diversity, and rapid increases in the price of seed." Leahy promised that the Senate Committee on Agriculture would hold hearings the next year "into the broad effects of PVPA," because "the possible ramifications of the plant patenting process on smaller seed companies and our germplasm resources are too great to do otherwise."[81] However, the 1980 elections brought a Republican majority to the Senate and a new chairman to the agriculture committee -- the conservative Republican Jesse Helms, of North Carolina, who did not schedule the promised hearings.

Such hearings would have served a public interest, since the critics of the PVPA and biotechnology patents did raise troublesome issues for public policy: The loss of genetic diversity and the trend to concentration in the plant and seed industry were genuine. However, it was questionable whether they were the result of the grant of intellectual property protection to plants. Loss of diversity had followed upon the Green Revolution, which involved innovations without intellectual property protection. Plant variety certificates may have figured to some extent in the growing agribusiness concentration, but, like patents in other industries, they could also be extremely valuable to small start-up firms in attracting venture capital.

Indeed, the evidence suggests that, contrary to the fears of the critics and consistent with Congressman de la Garza's rebuttal of them, the enlargement of intellectual property protection to include seed-propagated plants had increased rather than reduced the number of plant varieties available to the American public. For example, as many new varieties of wheat were developed in the seven years after the passage of the PVPA as in the seventeen years before it. In the decade after 1970, the number of seed companies increased, especially in wheat, cereal grains, and soybeans (before that year, six companies had been engaged in the development of soybean varieties; by 1980, the number was twenty-five). During the same period, almost 1,000 applications were submitted for plant variety protection certificates on 57 distinct crops. About ten percent of these came from agricultural experiment stations at colleges and universities; about twenty percent, from the six largest U.S. seed companies; and almost 70%, from private breeders of all sizes.[82]

In the early 1980s, free-market incentives and hitech competitiveness became the hallmarks of agricultural innovation. While the biotechnology industry that mushroomed into existence at the end of the 1970s had at first been concerned primarily with pharmaceuticals, by the beginning of the 1980s investors were paying greater attention to scientists like Raymond Valentine, a plant geneticist at the University of California, Davis, and a founder of the biotech firm Calgene, who told Newsweek: "Potentially any gene or genetic trait can be inserted into any plant to produce any results. This is the beginning of the second green revolution." By the beginning of the 1980s, the biotech industry included a substantial and growing agricultural sector comprising giant petrochemical firms like the Monsanto Corporation and small startups like Calgene. The firms were trying to engineer plants genetically so that they would, for example, have greater disease resistance or be able to fix their own nitrogen.[83]

Such engineering promised to overcome the longstanding problem of biological specificity in intellectual property protection for plants. Like the Plant Patent Act, the PVPA recognized the problem in its requirements that a plant qualifying for a certificate did not have to meet the key criteria for an industrial patent -- that is, be novel, nonobvious to those skilled in the art, and useful -- but only had to demonstrate distinctiveness, uniformity, and stability. These were criteria of identification and quality rather than of some innovative essence, which defied specification. However, plant developments that involved molecular genetic intervention amounted to innovations whose essence could be defined with chemical specificity and whose character could be expected to be transmitted intact through the generations.

At the same time, the Supreme Court had opened a broad precedent by conceding that, so far as the patent laws were concerned, life is chemistry and that any new composition of matter made by man qualified for a patent, no matter whether it was dead or alive. In the view of patent lawyers, there was no logical space between the patentability of a microorganism and of a higher

life form, including plants and animals. Indeed, it was precisely the premises and reasoning that lay behind the the Chakrabarty ruling that led, in 1985, to the grant of a utility patent to Kenneth Hibberd, a scientist at a subsidiary of Molecular Genetics Research, Inc., in Minnetonka, Minnesota. Hibberd had applied for a patent under the industrial patent laws for a type of genetically engineered corn -- "a maize seed having an endogenous free tryptophan content of at least one-tenth milligram per gram dry seed weight and capable of germinating into a plant capable of producing seed" with the same level of free tryptophan.[84] The Patent Office examiners denied the application, claiming that Congress had intended plants to be protected exclusively under the Plant Patent Act and the PVPA. However, the Patent and Trademark Appeals Board held, in Ex parte Hibberd, that the utility patent law (35 USC 101) "has not been narrowed or restricted" by the passage of the PPA or PVPA, that it predated both acts, and that -- with genuflection to *Diamond v. Chakrabarty* -- these plant-specific acts did not "represent exclusive forms of protection for plant life."[85]

By 1988, 42 utility patents had been issued for crop plants, including 11 for corn, six for sunflowers, and five for soybeans.[86] The number was hardly large, not least because expectations of quick genetic engineering innovations in plants proved to be highly exaggerated. However, the drive for plant patenting has steadily beaten back even the traditional European opposition to the practice. The European Patent Convention, adopted in 1973 to supersede the Strasbourg Convention of a decade earlier, included a clause that went beyond the Strasbourg provisions by prohibiting patents on plant and animal varieties.[87] However, in 1988, the Technical Board of Appeals of the European Patent Office upheld a patent claim on "propagative material [seeds] for cultivated plants, treated with an oxime derivative," since the propagating material claimed was not in the genetically fixed form of the plant variety, excluded by the European Convention.[88]

In March 1991, UPOV, meeting in Geneva, voted to abolish its prohibition against double protection, subject to ratification by the member states, and it seemed likely that the patentability of plants and animals would soon be allowed in the European Patent Convention by case decision, revision of the convention, or both.[89]

The pending shift has been a consequence of the hitech policymaking that takes biotechnology to be an essential part of the armamentarium of international competitiveness. It has also resulted from the fact that molecular biology has not only transformed plant innovation but also made biological specification of the innovation exact.

The historical record suggests that if any single category of developments has shaped the evolution of intellectual property protection for plants in the United States (and probably elsewhere), it is advances in biological specificity and control over reproduction. Biological science has, of course, not determined the system of intellectual property protection for plants that has come to prevail. The historical record makes indelibly clear that the current system has

been produced by the melding of technical developments with economic and political forces, particularly the constant determination of private breeders to exploit their products. But in the absence of specificity and control, private breeders were content to let their public counterparts bear the principal costs of plant innovation and to exploit the public product for market purposes. The greater the degree of specificity and control, the stronger the incentive for the private breeder to invest in innovation, because he could define it and thus seek to protect and enforce his right in it. Indeed, at each turning point in the development of intellectual property protection for plants -- in 1930, 1970, and 1983 -- the change in law or policy has expressed the state of specificity and control available at the time and provided a strength and scope of protection consistent with it. Now that plant innovation has become so much a matter of biochemistry and molecular genetics -- so hi-tech, one might say -- its structure of research and development has come increasingly to resemble that of other hi-tech industries: the federal government bears the costs of basic research, yielding the public good of knowledge useful to the entire plant industry, while private breeders exploit that knowledge to develop innovations in plants, confident that they can obtain intellectual property protection for the results.

Endnotes

1. U.S. Congress, House, Committee on Patents, Arguments on H.R. 18851, to Amend the laws of the United States Relating to Patents in the Interest of the Originators of Horticultural Products, 49th Cong., 1st Sess., May 17, 1906; Richard P. White, A Century of Service: A History of the Nursery Industry Associations of the United States (American Association of Nurserymen, 1975), pp. 128-32. The provisions of the Plant Patent Act are discussed in Robert Starr Allyn, The First Plant Patents: A Discussion of the New Law and Patent Office Practice (Brooklyn, NY: Educational Foundations, 1934).

2. P.L. 91-577 (Dec. 24, 1970).

3. P.L. 96-574 (Dec. 22, 1980); *Diamond v. Chakrabarty*, 447 U.S. 303, 100 S.Ct. (1980), 2207; *Ex Parte Hibberd, et al.*, 227 USPQ 443.

4. Jack R. Kloppenburg, Jr., First the Seed: The Political Economy of Plant Biotechnology, 1492-2000 (New York: Cambridge University Press, 1988), pp.50-64; Diane B. Paul and Barbara A. Kimmelman, "Mendel in America: Theory and Practice, 1900-1919," in R. Rainger, K. Benson, and J. Maienschein, eds., The American Development of Biology (Philadelphia: University of Pennsylvania Press, 1988), p. 288. Kloppenburg's excellent study considers intellectual property protection as secondary to its primary subject, the commodification of the seed. We differ from Kloppenburg in taking such protection as our primary concern and we depart from him on several fundamental points of interpretation.

5. Kloppenburg, First the Seed, pp. xii-xiii, 50, 59-64, 67-68, 77-78, 81-83, 12-13.

6. Ibid., pp. 71-72.

7. Hyland C. Kirk, "Brief on House Bill 18851 . . . , " and discussion, U.S. Congress, House, Committee on Patents, Arguments on H.R. 18851, May 17, 1906, p. 7; Dickson Terry, The Stark Story: Stark Nurseries 150th Anniversary (Missouri Historical Society, 1966), p. 84.

8. Peter Dreyer, A Gardener Touched with Genius: The Life of Luther Burbank (rev.ed.; Berkeley: University of California Press, 1985), pp. 106-7. According to a news feature, in a few cases, breeders made "small fortunes . . . by running up the price for the original stock of berries, fruits, or flowers." "Patenting of Plants Promises Big Profits -- and Problems," Business Week, Aug. 26, 1931, p. 26.

9. "Plant Patents," Science - Supplement, 71(April 25, 1930), xiv; U.S. Congress, Senate, Congressional Record, April 17, 1930, p. 7200; [REFRENCE RE STARK TO BE ADDED IN PROOF]. Similar arrangements were common in Europe, where the purchaser of a new variety of flower might have to agree to sell only cut flowers, not to give up any reproductive part of the plant, to cultivate only a fixed and limited number of plants, to meet certain standards of cultivation, and to pay penalties for violation of the contract. See Marie-Angèle Hermitte, "Histoires Juridiques Extravagantes: La Reproduction Vegetale," in J.-C. Fritz and Ph. Kahn, eds., La Gestion des Ressources Naturelles d'Origine Agricole, (Paris: Librairies Techniques, 1983), p. 255. A revised and updated version has been published in

Bernard Edelman and Marie-Angèle Hermitte, eds., L'Homme, La Nature, et Le Droit (Paris: Christian Bourgeois, 1988), pp. 40-82.

10. Judith I. Stallmann, Impacts of the 1930 Plant Patent Act on Private Fruit Breeding Investment (Ann Arbor: U.M.I. Dissertation Information Service, 1986), pp. 11-14; Terry, The Stark Story, p. 38.

11. Fritz Machlup, "Patents," International Encyclopedia of the Social Sciences, ed., David L. Sills (New York: Macmillan, 1968), XI, 461-64; Bruce W. Bugbee, Genesis of American Patent and Copyright Law (Washington, D.C.: Public Affairs Press, 1967), p. 152.

12. *Diamond v. Chakrabarty*, 447 U.S. 303, 100 S.Ct. (1980), 2207.

13. *Ex Parte Latimer*, March 12, 1889, C.D., 46 O.G. 1638, U.S. Patent Office, Decisions of the Commissioner of Patents and of the United States Courts in Patent Cases. . . 1889 (Washington, D.C.: Government Printing Office, 1890), pp. 123-27. See also H. Thorne, "Relation of Patent Law to Natural Products," Journal of Patent Office Society, 6 (1923), pp. 23-28.

14. White, A Century of Service, p. 129.

15. The bill had originally been designed to authorize the Commissioner of Patents to register, and allow the exclusive use of, new plants for twenty years under the Trade Mark Law. It was amended into a plant patent bill. Hyland C. Kirk, "Brief on House Bill 18851 . . . ," and discussion, U.S. Congress, House, Committee on Patents, Arguments on H.R. 18851, May 17, 1906, pp. 5-7, 12-13; Jack Doyle, Altered Harvest: Agriculture, Genetics, and the Fate of the World's Food Supply (New York: Penguin Books, 1986), p.50.

16. Terry, The Stark Story, pp. 48-51; Hermitte, "Histoires Juridiques Extravagantes: La Reproduction Vegetale," in J.-C. Fritz and Ph. Kahn, eds., La Gestion des Ressources Naturelles d'Origine Agricole, pp. 272-3.

17. Some 10,000,000 homes were said to need the services of nurserymen: Only 22% of front yards were planted; of rear yards, only 7%. "American Association of Nurseryman's Convention, Billion Dollar Market Indicated by Survey," The National Nurseryman, 36(July 1928), 201.

18. Terry, The Stark Story , p.66.

19. Ibid., pp. 84-86; Doyle, Altered Harvest, pp. 51-53.

20. Richard B. Carter, Clearing New Ground: The Life of John G. Townsend, Jr. (privately printed, n.d.), pp. 349-52, 401-403; Doyle, Altered Harvest, pp. 51-53; Dreyer, A Gardener Touched with Genius, p. 218. The largest orchardist in the country was reputedly Harry Flood Byrd, a Senator from Virginia and Townsend's good friend. Carter, Clearing New Ground, p. 352. Townsed celebrated the brains among the one third of the American poplation who worked on the land, noting: "Today we are, and for a century we have been, wasting this dormant talent that needs ony to be awakened by the hope of ultimate reward to bring into being marvels of plant life comparable in value to anything that the industrial genius has given to our civilization." "The Importance of Plant Patents to Agriculture: A Statement by Hon. John G. Townsend, Jr. . . . ," The National Nurseryman, April 1, 1930, p. 5.

21.U.S. Congress, Senate, Congressional Record, 71st Cong. 2d Sess., April 9, 1930; April 17, 1930; May 12, 1930, 6765, 7200-7201, 8750.

22. House Report No. 1129, 71st Cong., 2d Sess., April 10, 1930, Plant Patents, pp. 11-12; U.S. Congress, House Committee on Patents, 71st Cong., 2d Sess., Hearing on H.R. 11372: A Bill to Provide for Plant Patents, April 9, 1930, p. 3.

23. U.S. Congress, Congressional Record, 71st Cong., 2d Sess., May 5, 12, and 13, 1930, pp. 8391, 8751, 8866; Doyle, Altered Harvest, p. 55. Identical bills for plant patents were introduced in the House and the Senate on February 11, 1930. Allyn, The First Plant Patents, p. 60.

24. House Report No. 1129, 71st Cong., 2d Sess., Plant Patents, April 10, 1930, pp. 16-17.

25. Paul Stark, "Report," attached to Paul Stark to Tom Brennan, March 8, 1968, U. S. Congress, Senate, Patent Law Revision: Hearings before the Subcommittee on Patents, Trademarks, and Copyrights of the Committee on the Judiciary, 90th Cong., 2d Sess., Part 2, Jan. 30, 31, and Feb. 1, 1968, p. 865.

26. Ibid., pp. 862-63.

27. "Patents on Plants," Science -- Supplement, 71(April 25, 1930), xiv.

28. Allyn, The First Plant Patents, pp. 52, 55, 86, 90, 92, 97. Burbank's estate obtained a total of 15 plant patents through 1944. As of 1966, Stark Nurseries had acquired exclusive rights to 89 plant patents. Allyn, Plant Patents, 1934-1944 (Brooklyn, NY: Corsi Press, 1944), p. 9; Terry, The Stark Story, p. 87.

29. Kloppenburg, First the Seed, p. 133.

30. Allyn, The First Plant Patents, pp. 18-38; Robert C. Cook, "Other Plant Patents," Journal of Heredity, 24(February 1933), 49-54.

31. Allyn, The First Plant Patents, pp. 18-38.

32. Ibid., especially pp. 14, 18.

33. "Patenting of Plants Promises Big Profits--and Big Problems, Business Week, Aug. 26, 1931, p.26.

34. Botanical gardens increasingly allied themselves with variety associations to maintain type plants. For instance, in 1946 the Huntington Gardens in Pasadena, California became the repository of all known varieties of camelias, a project sponsored by the Southern California Camellia Society. Botanical Gardens/Henry E. Huntington Institution Archives, Henry E. Hungtington Library, San Marino, CA, (50.11) [CHECK SPELLING OF CAMELLIA, IN THE NAME OF THE SOCIETY.]

35. U.S. Patent Gazette, January 1950.

36. Kloppenburg, First the Seed, pp. 13, 81; John I. Sutherland to John L. McClellan, March 28, 1968, U. S. Congress, Senate, Patent Law Revision: Hearings before the Subcommittee on Patents, Trademarks, and Copyrights of the Committee on the Judiciary, 90th Cong., 2d Sess., Part 2, Jan. 30, 31, and Feb. 1, 1968, p. 750. [ADD ADDITIONAL REFERENCE IN PROOF FOR BEGINNING OF PAR.?]

37. See testimony of M. A. McCall, head of the department of agriculture Seed Policy Committee, U.S. Congress, House, Committee on Agriculture, Hearing, Federal Seed Act, 76th Cong., 1st Sess., March 23, 1939, pp. 18-21. [ADD PL NO. FOR FSA IN PROOF]

38. F.G. Parson, "Certification as a Device for Protecting Breeders' Rights"; John G. Dorsey, "U.S. Laws and Regulations on Protection of Varieties and Juridical Requirements for Breeders' Rights," both in Plant Breeders' Rights, pp. 23, 64-65; Kloppenburg, First the Seed, pp. 133-36.

39. Edward M. East and Donald M. Jones, Inbreeding and Outbreeding: Their Genetic and Sociological Significance (Philadelphia: J.B. Lippincott, 1919), p. 168, quoted in Paul and Kimmelman, "Mendel in America: Theory and Practice, 1900-1919," in Rainger, Benson, and Maienschein, eds., The American Development of Biology, p. 300; Paul Stark, "Report," attached to Paul Stark to Tom Brennan, March 8, 1968, U. S. Congress, Senate, Patent Law Revision, pp. 862-63.

40. A. Richard Crabb, The Hybrid Corn Makers: Prophets of Plenty (New Brunswick: Rutgers University Press, 1947); Deborah Fitzgerald, The Business of Breeding: Hybrid Corn in Illinois, 1880-1930 (Ithaca: Cornell University Press, 1990), pp. 132, 210.

41. E.G. Heyne and G.S. Smith, "Wheat Breeding, " in K.S. Quisenberry, ed., Wheat and Wheat Improvement, Agronomy Series, no. 13 (Madison: American Society of Agronomy, Inc., 1967), pp. 281-83. For a fuller discussion, see Rebecca Ullrich, "Some Facts About Plant Breeding, 1930-1970," California Institute of Technology, Humanities Working Paper No.146, June 1991.

42. U.S. Department of Agriculture, Report of the Secretary of Agriculture, 1958 (Washington, D.C.: U.S. Government Printing Office, 1959), p. 11; Virgil A. Johnson, "Better Cereals Sought in Fight Against World Hunger Problem," in United STates Department of Agriculture, Contours of Change. Yearbook of Agriculture, 1970 (Washington, D.C.: U.S. Government Printing Office, 1970), p. 329; Jules Janick, Robert W. Schery, Frank W. Woods, and Vernon W. Ruttan, Plant Science: An Introduction to World Crops, (2nd ed.; San Francisco: W.H. Freeman and Company, 1974), p. 403; John Milton Poehlman, Breeding Field Crops (New York: Henry Holt and Company, Inc., 1959), pp. 101-102; E.R. Sears, "Genetics and Farming," in Science in Farming. The Yearbook of Agriculture, 1943-1947 (Washington, D.C.: U.S. Government Printing Office, 1947), p. 255.

43. Hermitte, "Histoire Juridique Extravagantes," in Edelman and Hermittte, eds., L'Homme, La Nature, et Le Droit, pp. 65-68; Doyle, Altered Harvest, pp. 63-64.

44. U. S. Department of Commerce, Bureau of the Census, Historical Statistics of the United States, Colonial Times to 1970. Bicentennial Edition, Part I. (Washington, D.C.: Government Printing Office, 1975), pp. 210-11, 484, 488-89. An index in the growth of the seed industry is provided by the fact that in 1929, there were 316 seed wholesalers in the United States; in 1954, 563. U.S. Department of Commercie, Bureau of the Census, Census of American Business: 1933. Wholesale Distribution, Vol. I, Summary for the United States (Washington, D.C.: U.S. Government Printing Office, 1935), p. A3; United States Census of Business: 1954, Vol. III, Wholesale Trade-Summary Statistics (Washington, D.C.: U.S. Government Printing Office, 1957), pp. 6-20, 6-2.

45. Kloppenburg, First the Seed, pp. 169-70.

46. Stephen A. Bent et al, Intellectual Property Rights in Biotechnology Worldwide (New York: Stockton Press, 1987), pp. 40-47.

47. Ibid.

48. Ibid., pp. 47-50.

49. Ibid., p. 65.

50. Other international bodies had been advocating breeder's rights. At the 1951 meeting of the Council of Europe in the Hague, its Committee of Plant Experts recommended plant patenting laws and treaties among its members. The European Conference for the Development of Production and Commerce of Seeds -- part of the European Organization of Economic Development -- also recommended plant patenting at its 1954 meeting. Gunnar H. W. Weibull, "Breeder's Rights Systems in Europe," in Plant Breeders' Rights, p. 8; Bent et al, Intellectual Property Rights in Biotechnology Worldwide, pp. 54-58. For the origins and operations of UPOV, see also Marie-Angèle Hermitte, "Biotechnologies et Agriculture: La Protection de l'Innovation," Rapport a l'Office Parlementaire des Choix Technologiques," Oct. 1, 1990 (unpublished ms., copy in author's possession), Chapter III. In English, UPOV is the International Union for the Protection of Plant Varieties.

51. Bent et al, Intellectual Property Rights in Biotechnology Worldwide, pp. 57-62.

52. Ibid., pp. 56-58.

53. U.S. Congress, Senate, Congressional Record, 90th Cong., 1st Sess.,Feb. 21, 1967, p. 4075; Orville L. Freeman to John L. McClellan, Feb. 29, 1968, U. S. Congress, Senate, Patent Law Revision, pp. 715, 748-51.

54. Freeman to McClellan, Feb. 29, 1968; Paul Stark, "Report," attached to Stark to Brennan, March 8, 1968; Charles B. Shuman, president, American Farm Bureau Federation, to McClellan, March 26, 1968, U.S. Congress, Senate, Patent Law Revision, pp. 714-15, 748, 877. The Department of Agriculture had flatly declared to a recent Presidential Commission that it did not "consider the patent system the proper vehicle for the protection of [plants and seeds] regardless of whether the plants reproduce sexually or asexually." "President's Commission's Recommendation Concerning Plant Patents," Federal Register, 33(3 January 1968), 29.

55. Robert F. Lederer, executive vice president, American Association of Nurserymen, to McClellan, Feb. 21, 1968; John I. Sutherland to McClellan, March 28, 1968, U.S. Congress, Senate, Patent Law Revision, pp. 748-51; Kloppenburg, First the Seed, pp. 133-34.

56. The House bill was HR13424. U.S. Congress, House, Congressional Record, 91st Cong., 1st Sess., Aug. 11, 1969, p. 23180; 2d Sess., Aug. 21, 1970, p. 29691; September 29, 1970, p. 34074; October 2, 1970, p. 34675; U.S. Senate, Committee on Agriculture and Forestry, Hearing: Plant Variety Protection Act, 91st. Cong., 2d Sess., June 11, 1970, p. 82.

57. U.S. Congress, House, Congressional Record, 91st Cong., 2d Sess., Dec. 8, 1970, pp. 40293, 40303.

58. For two weeks after the bill passed, several members of the Nixon administration recommended that the president veto the act. Virginia Knauer, the president's special assistant for consumer affairs, argued that the act "seems likely to create some degree of market power in producers, and will require a sizeable government apparatus to administer." Deputy Attorney General Richard Kleindienst contended that major food and fiber crops should not "be subject to private restraints." For reasons unknown, George Schultz, director of the Bureau of the Budget, convinced Nixon to sign the Act. Office of Management and Budget File on P.L. 91-577 (file #T5-22/69.2), in Office of Legislative Reference, Record Section Depository, New Executive Office Building, Washington, D.C. Cited in Doyle, Altered Harvest, 63-64.

59. For the provisions of the act, see text of P.L. 91-577 (Dec. 24, 1970); U.S. Congress, House, Congressional Record, Dec. 8, 1970, p. 40303; Doyle, Altered Harvest, pp. 61-62; testimony of Eldrow Reed, of the Campbell Soup Co., U.S. Senate, Committee on Agriculture and Forestry, Hearing: Plant Variety Protection Act, pp. 83-84.

60. By 1979, the PVPO had computerized 14,000 plant variety descriptions of 79 crops. U.S. Congress, House, Hearings before the Subcommittee on Department Investigations, Oversight, and Research of the Committee on Agriculture, Plant Variety Protection Act Amendments, 96th Cong., 1st and 2d Sess., July 19, 1979 and April 22, 1980, p. 13 [hereafter cited as Hearings: PVPA Amendments.]

61. American farmers have a tradition of selling surplus seeds to their neighbors, and almost all of the infringement litigation over the act has focused on this farmers exemption, specifically over when a farmer turns into a seedsmen. Holders of PVPCs have seldom profited in proportion to how widely their variety has been grown. For instance, the USDA found that 46% of all wheat planted in 1986 was from saved seed. U.S. Congress, Office of Technology Assessment, Patenting Life, OTA-BA61.2267-370 (Washington, D.C.: Office of Technology Assessment, April 1989), p. 79.

62. William H. Lesser and Robert T. Masson, An Economic Analysis of the Plant Variety Protection Act (Washington, D.C.: American Seed Trade Association, 1983), p. 58.

63. Bent et al, Intellectual Property Rights in Biotechnology Worldwide, pp. 436-41.

64. U.S. Congress, Senate, Congressional Record, 96th Cong., 1st Sess., January 15, 1979, p.233; July 26, 1979, p. 20835; 2d Sess., June 12, 1980, p. 14408. The Heinz Company also felt that the PVPA "should eliminate the high cost and uncertainties of production associated with the Hybrid System." Letter from B.F. George, H.J. Heinz Company; statement of William D. McDowell, W. Atlee Burpee Company, Hearings: PVPA Amendments, pp. 29, 125, 325; [NEED CITE FOR DOCUMENT ON P. 125] Bent et al, Intellectual Property Rights in Biotechnology World Wide, p. 473.

65."Application of Malcolm E. Bergy . . .," June 10, 1974, in United States Court of Customs and Patent Appeals, Transcript of Record, Patent Appeal Docket No. 76-712, In Re Application of Malcolm E. Bergy, et al, Filed August 16, 1976, p. 6; telephone conversation with Roman Saliwanchik, Oct. 14, 1988.

66."Letter of Examiner, Feb. 6, 1975"; Roman Saliwanchik, "Brief," March 18, 1975; "Opinion and Decision of Board of Appeals, June 22, 1976," in United States Court of Customs and Patent Appeals, Transcript of Record, Patent Appeal Docket No. 76-712, In Re Application of Malcolm E. Bergy, et al, Filed August 16, 1976, pp. 34, 54, 62-63.

67. In the matter of the Application of Malcolm E. Bergy et al, 563 F. 2d, 1037-1038 (1977).

68. Application of Ananda M. Chakrabarty, 571 F 2d, 43-44 (1978).

69. In the Supreme Court of the United States, Parker v. Bergy et al and Parker v. Chakrabarty, Brief on Behalf of the People's Business Commission, Amicus Curiae, Dec. 1979, p.pp. 5-9; Committee on Genetic Vulnerability of Major Crops . . . National Research Council, Genetic Vulnerability of Major Crops (Washington, D.C.: National Academy of Sciences, 1972), p.1. See also United States, National Plant Genetics Resources Board, Plant Genetic Resources: Conservation and Use (Washington, D.C.: Dept. of Agriculture, National Plant Genetic Resources Board, 1979).

70. In the Supreme Court of the United States, Parker v. Bergy et al and Parker v. Chakrabarty, Brief on Behalf of the People's Business Commission, Amicus Curiae, Dec. 1979, pp. 7-9, 12-13.

71. Hearings: PVPA Amendments, pp. 68, 73, 101-2, 226, 274.

72. Ibid., p. 64. Prior to 1970, Campbell Soups released 32 varieties of tomatos to the public, and none after. Ibid., p. 145. Nabhan also objected to the granting of an intellectual property right in a natural product like a plant. "Such legislation gives credence to breeders who can manipulate one or two genes of a traditional land race that evolved over thousands of years and then claim that something novel has been created. . . . Privately employed plant breeders can even cross two varieties derived from many years of research done by the USDA or universities and then patent a hybrid as their own creation. U.S. House, Hearings: PVPA Amendments, p. 63. In a later book, Nabhan would write, "Few of the edible, nutritional characteristics of the seed plants that now sustain us evolved for our benefit, under selective pressure from our forebears or through conscious breeding by scientists. We are literally living off the fruits of other creature's labors -- those of the birds, bugs, and beasts that loosely coevolved with seed plants over the last hundred million years." Gary P. Nabhan, Enduring Seeds: Native American Agriculture and Wild Plant Conservation (San Francisco: North Point Press, 1989) 6.

73. *Diamond v. Chakrabarty*, 447 U.S. 303, 100 S. Ct. 2204 (1980) at 2206-2212.

74. In the Supreme Court of the United States, Parker v. Bergy et al and Parker v. Chakrabarty, Brief on Behalf of the People's Business Commission, Amicus Curiae, Dec. 1979, pp. 11-12, 21-22, 27, 29-30; Roman Saliwanchik, "Brief in Opposition to Petition for Writ of Certiorari . . .," In the Supreme Court of the United States, October Term 1977, No. 77-1503, Lutrelle F. Parker v. Malcolm E. Bergy, filed May 11, 1978, pp. 6-7; "Brief Amicus Curiae of the Regents of the University of California," U.S. Court of Customs and Patent Appeals, Patent Appeal Dockets Nos. 76-712 and 77-535, In the Matter of . . . Bergy and In the Matter of . . . Chakrabarty, pp. 1, 2, 14-20; "Motion for Leave to Appear as Amicus Curiae and Brief Amicus Curiae of Genentech, Inc.," In the Matter of . . . Chakrabarty, Patent Appeal No. 77-

535, United States Court of Custom and Patent Appeals, filed Sept. 20, 1978, pp. 1b-1d, 6, 8-9, 12-13; In the matter of the Application of Malcolm E. Bergy et al, 563 F. 2d, 1037-1038 (1977).

75. *Diamond v. Chakrabarty*, 447 U.S. 303, 100 S. Ct. 2204 (1980), pp. 2206-2212.

76. Hearings: PVPA Amendments, p. 184

77.U.S. Congress, Congressional Record, 96th Cong., 2d Sess., November 17, 1980, p.29941. Representative Thomas S. Foley, of Washington, pointed out that the soup vegetables, excluded from protection, had seen "less development of new varieties," almost all of which have been hybrids, "as contrasted with those vegetables which have been covered by the act." Ibid. For systematic assessments of the impact of the PVPA, see L.J. Butler and B.W. Marion, The Impacts of Patent Protection on the U.S. Seed Industry and Public Plant Breeding (Madison, Wisconsin: University of Wisconsin, September 1985),p. 79; Lesser and Masson, An Economic Analysis of the Plant Variety Protection Act.

78. U.S. Congress, House, Congressional Record, 96th Cong., 2d Sess., Nove. 17, 1980, p.29941.

79. U.S. Congress, Senate, Congressional Record, 96th Cong., 1st Sess., July 26, 1979, p. 20835; 2d Sess., June 12, 1980, p.14408; Bent et al, Intellectual Property Rights in Biotechnology World Wide, p. 473.

80. U.S Congress, House, Congressional Record, 96th Cong., 2d Sess., November 17, 1980, p. 29942.

81. Ibid., December 9, 1980, p. 33112.

82. *Diamond v. Chakrabarty*, Brief on Behalf of the Pharmaceutical Manufacturers Association, Amicus Curiae, Jan. 1980, pp. 13, 26-29, 48; Brief on Behalf of Genentech, Inc., Amicus Curiae, Jan. 1980, pp. 13, 17-18.

83. Newsweek, August 10, 1981, p. 74; The New York Times, June 28, 1981, sec. 3, pp. 1, 20; John Walsh, "Biotechnology Boom Reaches Agriculture," Science, 213(Sept. 18, 1981), p. 1339-40; Kloppenburg, First the Seed, p. 16.

84. U.S. Patent #4,581,847, 1985.

85. *Ex Parte Hibberd, et al.*, 227 USPQ 443.

86. Office of Technology Assessment, Patenting Life, p.76.

87. The stricture is in Article 53 (b) of the 1973 convention. R.S. Crespi, Patents: A Basic Guide to Patenting in Biotechnology. Cambridge Studies in Biotechnology #6 (Cambridge University Press, 1988), p. 111. See also Bent, et al, Intellectual Property Rights in Biotechnology Worldwide, pp. 65-69.

88. Crespi, Patents, p. 114.

89. European Parliament, Working Document of the Committee on Legal Affairs and Citizens' Rights on the Commission Proposal for a Council Regulation on Community Plant Variety Rights (COM(90) 347 final -C3-303/90), April 4, 1991, pp.

4-5. For a discussion of the relationship of intellectual property protection for plants in the European Community and UPOV, see Marie-Angèle Hermitte, "Biotechnologies et Agriculture: La Protection de l'Innovation," Rapport a l'Office Parlementaire des Choix Technologiques," Chapter V.